PYROTECHNICAL FIRING INSTALLATION

BACKGROUND OF THE INVENTION

In mines and quarries the breaking of rocks is carried out by means of explosives.

A firing program consists of making a plurality of drill-holes in the rock, which are filled with explosives with, for every drill-hole, a detonator that permits the firing. Some of these detonators are electronically controlled, which makes it possible to program the setting off of the explosions according to a predetermined firing plan.

The execution of a firing plan consists, therefore, after having arranged all the detonators in the drill-holes that have been made and connecting them to a control unit or firing box, of identifying every detonator by a serial number and applying to it a delay time which will determine the moment of ignition of the charge in relation to a general firing signal.

Electronic detonator systems receive power and control signals from a bus or surface line, connected to the firing box and extending over the firing range so as to connect all the detonators.

A detonator generally comprises an electronic module in the form of a tubular sheath, one end of which is provided to receive the pyrotechnical blasting cap. From the other end of this tubular sheath there exits an electric cable with a length roughly equal to the drilling depth of the drill-holes. The end of this cable carries connection means such as, for

example, clips that make it possible to connect each of the wires, without baring them, to the two-wire line running over the firing range.

The putting into position of the ground bus or surface line of the firing range is a very inconvenient operation. Furthermore, the connection of each of the detonators to this line requires special attention and creates a risk of errors.

SUMMARY OF THE INVENTION

The present invention aims to remedy these drawbacks mentioned above by doing away with the two-wire bus so that every detonator is equipped with only one cable for its connection to the programming and firing control means and to the other detonators of the firing plan.

To this end, the invention accordingly relates to a pyrotechnical firing installation comprising a plurality of detonators each with an electric cable comprising at least two conductors, and a surface line to which the cable of each detonator is connected, wherein the surface line is formed by sections, every section comprising a terminal or end part of the electric cable coming from a detonator and an end connector to electrically connect this terminal part to the cable of the next detonator at a point of the latter defining the origin of its terminal part.

In this way, the bus or surface line is formed as the detonators are connected to one another. It, therefore, is no longer necessary to use a special cable for forming the bus. Moreover, the connector permits the connection of a first detonator at any place whatsoever of the cable of the next detonator, so that one can provide a constant connecting cable length for all the detonators.

The invention also relates to a detonator comprising an electric cable, the free end of which is provided with a connector for implementing the

abovementioned installation, the connector comprising a first part solid with the end of the cable, provided laterally with connection pins and on the opposite side to these pins a pushing wall, and a second part comprising a slide and a stop wall, into which the first part is mounted movable in relation to the stop wall which faces the connection pins, the wall and the slide defining a seat suitable for receiving an electric cable oriented transversely to the cable equipped with the connector.

Thus, by means of this connector one can produce a lateral connection of the end of a cable to any place along the cable of the next detonator.
Other characteristics and advantages of the invention will be noted from the description given below by way of non-limitative example, of an exemplified embodiment.

BRIEF DESCRIPTION OF THE DRAWINGS

Reference will be made to the attached drawings, wherein:

Figure 1 is a diagram illustrating a pyrotechnical firing installation according to the invention;

Figures 2, 3 and 4 illustrate in a front, bottom and top view respectively, one part of a connector according to the invention;

Figures 5 and 6 illustrate in a front view and a side view a second part of a connector according to the invention; and

Figures 7 and 8 illustrate the cooperation of these two parts for the electrical connection of two successive detonator cables.

DESCRIPTION OF AN EMBODIMENT

The diagram of Figure 1 shows two blast-holes 1 and 2 belonging to a firing plan or program, in which are arranged two detonators 3 and 4, each of which is provided with an electric cable 5, 6 having at least two conductors coming out of the respective blast-hole. Each of the cables 5, 6 comprises at its free end a respective connector 7, 8. A central control unit or firing box 9 is equipped with an electric cable 10, the end of which is also provided with a connector 11. The connector 7 at the end of cable 5 according to the invention can be mounted on the cable 6 and ensure the electrical connection of the wires, or of some of them, of the cable 5 and cable 6. The connector 7 is placed on the cable 6 at a point which forms the origin of the terminal or end part 6a of cable 6. Likewise, the connector 11 of the cable 10 defines the terminal or end part 5a of cable 5. In this way the surface line, with the exception of cable 10, is formed by successive sections, which are the terminal parts 5a, 6a of the cables 5, 6. It will be understood that in this way there no longer is a special cable dedicated to the formation of a surface bus for the control and power supply of the detonators of a firing installation.

Figures 2 to 6 illustrate a special embodiment according to the invention of a connector such as 7, 8 or 11. The illustrated connector comprises a first part 20, for example of plastic material overmoulded at one end by a cable such as 5, 6 or 10, this first part 20 comprising four lateral pins 21, 22, 23, connected electrically to three conductors 25, 26, 27 of the electric cable, and a terminal 24 connected to a test wire 28. On the opposite side to the connection pins, the part 20 comprises a push wall 29 prolonged on the opposite side to the cable 5, 6, 10 by a flexible tab 30, which extends perpendicular to it and is provided with an opening 31 and a terminal gripping part 32. As illustrated, the part 20 has a cylindrical volume 33 in the extension of the electric cable, a cylindrical volume 34 which is perpendicular to the volume 33 and has roughly the same diameter, from one end of which the pins project, whereas at its other end the volume 34 is

connected to the push wall 29, which in turn is connected to the cylindrical volume 33 by a partition 35.

In Figures 5 and 6, the second part 36 of the connector according to the invention is shown, which comprises a slide 37 formed by two walls 38 and 39 and an end wall 40 perpendicular to these two walls 38, 39. The inside surface of the wall 40 is connected to the inside surfaces of the walls 38 and 39 by a cylindrical surface congruent with the cylindrical surface of the volume 34 of the part 20. The distance between the walls 38 and 39 is practically equal to the diameter of the cylindrical volume 33 of the part 20, whereas in the upper part these walls are provided with at least one inside bead 41, 42, which slightly reduces the distance between them, so that the inserting from above of the part 20 into the slide 36 requires a small amount of force in order to pass these beads.

The end wall 40 is prolonged under the slide 36 and has a part 43 extending from it at a right angle, which forms a stop wall facing the bottom opening of the slide. This stop wall 43 ends in an inclined gripping part 44, and at the point where it connects to the part 40, it has a fillet 45 which together with a bead 46 to the side of this fillet 45 forms a partial cradle so as to wedge into the seat formed between the plate 43 and the slide 36 and near the wall 40, a roughly cylindrical body that will be inserted into it, which body has a longitudinal axis extending perpendicularly to both the volume 33 and the volume 34 of the first part 20 when it cooperates with the second part 36. It will also be noted that there is an opening 43a in the right-angle wall 43, which opening is located just to the right of the place of the slide that receives the body 34 of the part 20.

Finally, it will be noted that there is a lug 47 on the outside surface of the end wall 40, which lug 47 is intended to penetrate into the opening 31 of the tab 30 of part 20.

The two parts of the connector of the invention are assembled in the waiting position illustrated in Figure 7. In this position the pins 21, 22, 23

are retracted inside the slide 36 so that one can insert into the cradle 45, 46 a cable 5 or 6, cylindrical but preferably having a flat side 48 (see Figure 8) parallel to the bundle of conductors 25, 26, 27 which it encloses. When, as in Figure 8, the cable 5, 6 is in position in the cradle, the connection is ensured by pushing on the plate 29, which moves the part 20 towards the stop wall 43 of the part 36, forcing the pins to penetrate into the inside of the cable 5, 6 until they reach the bundle of conductor wires. The connection position of the two parts 20 and 36 is then locked by the penetration of the lug 47 into the opening 31.

The special shape of the cable 5, 6 illustrated in Figure 8 constitutes a locating device for the putting in place of the connector on a detonator cable and guarantees a good electrical connection. It must be mentioned that in its position illustrated in Figure 7, the connector according to the invention permits the carrying out of control tests by introducing into the cradle 45, 46 a test probe, which will feel the pins and terminal of the part 20 so as to proceed with usage verifications before the detonator corresponding to the connector is connected to the next detonator cable. This probe is introduced into the opening 43a. It will be noted that in the presence of a cable this opening is closed off, which prohibits any measuring tests of a detonator already connected to the firing installation.

Taking into account the shape of the cable and its cooperation with the inside surface of the slide 36, the tightness of the connection is ensured. The gripping parts 32 and 44 of the tab 30 and stop plate 43 make it possible on the one hand to disconnect the pins so as to pull them out of the cable and on the other hand to disengage the cable from its seat in the cradle.

Because of the invention it is possible to produce on the ground a run of relatively tight wires since the connection of a cable to the next cable can be made anywhere. In this way one can take into account the different distances that separate the blast-holes in a firing plan without the ground

being encumbered by a surplus length of electric cables in which the feet of workers can become entangled and inopportunely break the connections.